REMARKS/ARGUMENTS

Claims

Claims 1-20 are pending.

Allowable Subject Matter

The Examiner stated that claims 4-7, 9-12, and 15 were objected to as being independent upon a rejected bas claim but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. The applicants appreciate the Examiner's comments. Claim 4-7, 9-12, and 15 will be so amended if required at a later time.

Claim Rejection under 35 USC 103

The Examiner rejected claims 1-3, 8, 13, 14, 16, 17, and 18-20 under 35 U.S.C. 103(a), as being unpatentable over Zhao et al. (6,261,963) in view of Welsch et al. (6,226,173) further in view of Carlson et al. (3,632,438) further in view of Stumborg et al. (6,211,066). The Examiner stated that regarding claim 1, Fig. 3 of Zhao et al. shows dielectric layer 120, copper layer 140, and barrier layer 325A and that Zhao et al. discloses that the barrier layer is one of titanium nitride, titanium tungsten, nitrided titanium-tungsten, magnesium, or another suitable barrier material (col. 5) but that Zhao et al. do not show this barrier layer to be an oxide layer doped with one of magnesium, calcium, strontium, beryllium, or barium, and that the abstract in Welsch et al. shows directionally grown capacitor anodes where the dielectric layer is doped with oxides of Ca, Mg, Sr, Be, and Ba. Regarding claims 2, 3, 17, 19, and 20, the Examiner further stated that the abstract section of Welsch et al. shows a directionally grown capacitor anodes where the dielectric layer is doped with oxides. Regarding claims 8 and 13, the Examiner stated that Fig.'s 3-10 show multiple layers of copper interconnect structure with multiple layers of dielectric and barrier. Regarding claims 14, 16, and 18, the Examiner stated that columns 8-12 show the method of making a copper interconnect with multiple layers. The Examiner then stated that Zhao et al. and Welsch et al. combination do not disclose the required ion dopant structure and the barrier layer structure, but that Carlson et al. disclose a method for increasing the stability of semiconductor devices where the required dopant structure is disclosed and that

Stumborg et al. discloses electronic devices with barium layer film and process for making the same where the required barrier layer structure is disclosed. The Examiner stated that it would have been obvious to have the required dopant structure and barrier layer structure in Zhao et al. and Welsch et al. combination as taught by Carlson et al. and Stumborg et al in order to have a semiconductor device with better stability.

It would not be obvious to combine the barrier layers of Zhao et al. with the dielectric layers doped with oxides of Ca, Mg, Sr, Be, or Ba of Welsch et al. to form the barrier layer comprising a silicon oxide layer doped with divalent ion dopant, as recited in claims 1, 14, and 18. The dielectric doped with oxides of Ca, Mg, Sr, Be, or Ba of Welsch is not the same thing as a silicon oxide layer doped with divalent ion dopant, as recited in claims 1, 14, and 18. Neither Zhoa et al. nor Welsch et al. teaches a silicon oxide layer doped with a divalent ion dopant. Instead, Welsch teaches a dielectric doped with oxides of Ca, Mg, Sr, Be, or Ba.

Even if the properties of a dielectric doped with oxides of Ca, Mg, Sr, Be, or Ba as taught by Welsch et al. were the same as a silicon oxide doped with a divalent ion, as recited in claims 1, 14, and 18, it would not be obvious that the dielectric doped with oxides of Ca, Mg, Sr, Be, or Ba would be a successful copper barrier layer. The Examiner has failed to show that the combined references would have a likelihood of success of providing a copper barrier layer using the doped dielectric of Welsch et al. The Examiner pointed to nothing in Zhao et al. or Welsch et al. that teaches that a dielectric doped with oxides of Ca, Mg, Sr, Be, or Ba would successfully form a copper barrier layer, which would keep copper from migrating through the layer past the barrier layer.

The Examiner stated that it would have been obvious to have a barrier dielectric layer of oxide doped with calcium in Zhao et al. as taught by Welsch et al. because such structure would provide a better protection. As mentioned above, Welsch does not teach a dielectric layer of oxide doped with calcium, but instead a dielectric layer doped with oxides of Ca, Mg, Sr, Be, or Ba. The Examiner did not cite anything in Zhao et al. or Welsch et al. that stated that the layer taught in Welsch would provide improved protection as a barrier layer. Instead, the abstract of Welsch et al. says such a layer improves the dielectric constant. The protection provided by the barrier layer is to prevent copper migration. Nothing in Zhao et al. and Welsch et al. suggests that a layer as taught in Welsch provides such copper migration protection.

The Examiner failed to specifically point out anything in Carlson that teaches the required dopant structure of a silicon oxide doped with divalent ion dopant. Since the Examiner failed to specifically point to anything in Carlson, the applicant believes the Examiner may be referring to, col. 6, lines 4-11, which teaches that a calcium doped silicon oxide layer may form a barrier layer as a barrier to sodium impurities. Nothing in Carlson teaches or suggests that the dopant structure would provide a sufficient copper barrier. The Examiner states that it would be obvious to place the barrier layer of Carlson between the dielectric layer and the copper layer to provide a semiconductor device with better stability. To prevent copper poisoning, it is required that a copper barrier layer prevents copper from migrating. It would not be obvious to use a layer that provides better semiconductor stability would be able to successfully function as a copper barrier layer. In addition, none of the cited references shows that the layer of Carlson would be successful as a copper barrier layer. If the layer of Carlson did not provide a copper barrier, then the resulting structure would fail due to copper poisoning.

The Examiner failed to specifically point out anything in Stumborg et al. that teaches the required dopant structure of a silicon oxide doped with divalent ion dopant. The applicant saw nothing in Stumborg that teaches or suggests a silicon oxide layer doped with a divalent ion dopant.

For at least these reasons, claims 1, 14, and 18 are not made obvious by Zhao et al. in view of Welsch et al. further in view of Carlson et al. further in view of Stumborg et al.

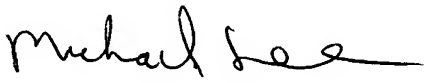
Claims 2, 3, 8, 13, 16, 17, 19, and 20 each depend either directly or indirectly from the independent claims and are therefore respectfully submitted to be patentable over the art of record for at least the reasons set forth above with respect to the independent claims. Additionally, these dependent claims require additional elements that, when taken in the context of the claimed invention, further patentably distinguish the art of record. For example, claim 8 is dependent on claim 6, and therefore incorporates all of the limitations of claim 6. In addition, claim 16 further recites placing a second silicon oxide layer on the surface of the copper containing layer and doping the second silicon oxide layer with a divalent dopant to form a second barrier layer. The references fail to teach or suggest this. For at least these reasons claims 2, 3, 8, 13, 16, 17, 19, and 20 are not made obvious be the cited references.

Applicant believes that all pending claims are allowable and respectfully requests a Notice of Allowance for this application from the Examiner. Should the Examiner believe that a

telephone conference would expedite the prosecution of this application, the undersigned can be reached at the telephone number set out below.

Respectfully submitted,

BEYER WEAVER & THOMAS, LLP



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